EXERCISE EQUIPMENT WITH AUTOMATIC ADJUSTMENT OF STRIDE LENGTH AND/OR STRIDE HEIGHT BASED UPON SPEED OF FOOT SUPPORT

FIELD OF THE INVENTION

[0001] This invention relates to exercise equipment, more specifically to stationary cardiovascular exercise equipment, and most specifically to elliptical exercise equipment.

BACKGROUND

[0002] One type of stationary cardiovascular exercise equipment which has become extremely popular based predominantly upon its low-impact and natural motion is the elliptical exercise machine. A wide variety of elliptical exercise machines have been developed. Briefly, elliptical exercise machines include foot supports supported upon foot links with the foot links pivotally connected at a first end through a linkage system to a drive shaft for travel along a defined closed loop path (*e.g.*, circular, elliptical, oval, *etc.*) and connected at the other end for reciprocating motion along a defined path as the first end travels along the closed loop path. This combination of looping and reciprocating paths of travel at opposite ends of the foot links impart an "elliptical" type motion to the foot supports attached to the foot links.

[0003] Such elliptical exercise machines permit a user to exercise at different speeds. This feature significantly enhances the value of the machine by permitting a user to exercise at varying speeds during a workout and exercise at speeds which suit them. However, the machines do not alter the path of travel of the foot supports to accommodate the inherent difference in stride when running / walking at different speeds.

[0004] Accordingly, a need exists for elliptical exercise machines which permit a user to exercise at varying speeds and alters the path of travel of the foot supports dependant upon the

speed at which the foot supports are traveling in order to accommodate the inherent difference in stride between faster and slower speeds.

SUMMARY OF THE INVENTION

[0005] A first embodiment of the invention is an exercise device comprising (i) a frame, (ii) first and second foot supports operably associated with the frame for traveling along a closed loop path relative to a transverse axis defined by the frame, (iii) a means effective for sensing the speed of travel of the foot supports along the closed loop path, and (iv) a means for automatically adjusting the stride length of the closed loop path traveled by the foot supports based upon the sensed speed of travel of the foot supports.

[0006] A second embodiment of the invention is an exercise device comprising (i) a frame, (ii) first and second foot supports operably associated with the frame for traveling along a closed loop path relative to a transverse axis defined by the frame, (iii) a means effective for sensing the speed of travel of the foot supports along the closed loop path, and (iv) a means for automatically adjusting the stride height of the closed loop path traveled by the foot supports based upon the sensed speed of travel of the foot supports.

[0007] A third embodiment of the invention is an exercise device comprising (i) a frame, (ii) first and second foot supports operably associated with the frame for traveling along a closed loop path relative to a transverse axis defined by the frame, (iii) a means effective for sensing the speed of travel of the foot supports along the closed loop path, and (iv) a means for automatically adjusting the stride length and stride height of the closed loop path traveled by the foot supports based upon the sensed speed of travel of the foot supports.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 is a perspective view of one embodiment of the invention.

[0009] Figure 2 is a side view of the invention shown in Figure 1 with the protective housing removed and depicting a single foot link and associated components.

[0010] Figure 3 is an enlarged view of the forward portion of the invention shown in Figure 2 depicting the first end portion of the foot link and associated dynamic components.

[0011] Figure 4 is an enlarged view of the rearward portion of the invention shown in Figure 2 depicting the second end portion of the foot link and associated supporting components.

[0012] Figure 5 is a side view of an alternate embodiment of the rear portion of the invention shown in Figure 2 depicting a single foot link and associated components.

[0013] Figure 6 is a side view of a second embodiment of the invention with protective housing removed and depicting a single foot link and associated components.

[0014] Figure 7 is an enlarged view of the forward portion of the invention shown in Figure 6 depicting the first end portion of the foot link and associated dynamic components.

[0015] Figure 8 is an enlarged view of the rearward portion of the invention shown in Figure 6 depicting the second end portion of the foot link and associated supporting components.

[0016] Figure 9 is a perspective view of a third embodiment of the invention with the protective housing removed to facilitate viewing of other components.

[0017] Figure 10 is a side view of the invention shown in Figure 9 with the protective housing removed and depicting a single foot link and associated components.

[0018] Figure 11 is an enlarged view of the forward portion of the invention shown in Figure 10 depicting the first end portion of the foot link and associated dynamic components.

DETAILED DESCRIPTION OF THE INVENTION INCLUDING A BEST MODE

Nomenclature

10	Exercise Device
20	Frame
21	Front Stanchion Portion of Frame
22	Rear Stanchion Portion of Frame
30	Drive Shaft
40	Crank Arm
40a	First End of Crank Arm
40b	Second End of Crank Arm
50	Drive Pulley
50a	Front Drive Pulley
50b	Rear Drive Pulley
60	Foot Link
60a	First End of Foot Link
60b	Second End of Foot Link
61p	Closed Loop Path of Travel for One End Portion of Foot Link
62p	Path of Travel for Other End Portion of Foot Link
69	Roller on Foot Link
70	Foot Support
70p	Closed Loop Path of Travel for Foot Support
80	Rocker Link
80a	First End of Rocker Link
80b	Second End of Rocker Link

90 Connector Link

90a First End of Connector Link

90b Second End of Connector Link

100 Brake

110 Braking Control System

120 Guide Rail

121 Rear Guide Arm

121a First End of Rear Guide Arm

121b Second End of Rear Guide Arm

130 Incline Adjustment System

140 Master Control Unit

150 User Interface Panel

160 Speed Sensing System

161 Magnet

162 Magnetic Sensing Element

171 First Pivot Point Repositioning Unit

172 Pivot Point Repositioning Unit

173 Pivot Point Repositioning Unit

174 Pivot Point Repositioning Unit

180 Inertia Generation System

181 Flywheel

182 Pulley (small diameter)

183 Shaft

184 Drive Belt

221 Front Guide Arm

221a First End of Front Guide Arm

221b Second End of Front Guide Arm

230 Linear Actuator

310 Support Shaft

320 Rocker Link

320a First End of Rocker Link

320b Second End of Rocker Link

330 Drawbar

330a First End of Drawbar

330b Second End of Drawbar

340 Timing Belt

p_1 First End Foot Link Pivot Point

p_2 Second End Foot Link Pivot Point

p_3 Rocker Pivot Point

p_4 Crank Pivot Point

p_5 Front Guide Arm Pivot Point

p_6 Rear Guide Arm Pivot Point

p_7 Rocker-Foot Pad Pivot Point

p_8 Rocker-Frame Pivot Point

p_9 Drawbar-Rocker Pivot Point

SH Stride Height

SL Stride Length

x Lateral Axis

x_1 First Lateral Direction

x_2 Second Lateral Direction

y Longitudinal Axis

z Transverse Axis

z_1 First Transverse Axis

z_2 Second Transverse Axis

Definitions

[0019] As utilized herein, including the claims, the phrase ***"extension element"*** includes any component attached to and extending substantially orthogonally from a drive shaft by which circular motion is imparted to the drive shaft. Exemplary extension elements include

specifically, but not exclusively, a bent portion of a drive shaft, a crank arm, a drive pulley, and rigidly or pivotally attached combinations thereof.

[0020] As utilized herein, including the claims, the phrase ***"stride height"*** means the vertical distance between highest and lowest vertical points along the path traveled by a foot support.

[0021] As utilized herein, including the claims, the phrase ***"stride length"*** means the linear distance between forward most and rearward most points along the path traveled by a foot support.

Construction

[0022] As shown in FIGs. 1-11, the invention is an exercise device **10** including at least (i) a frame **20** defining a transverse axis **z**, (ii) first and second foot supports **70** operably associated with the frame **20** for traveling along a closed loop path **70p** relative to the transverse axis **z** wherein the closed loop path **70p** defines a stride length **SL** and stride height **SH**, (iii) a means **160** effective for sensing the speed of travel of the foot supports **70** along the closed loop path **70p**, and (iv) a means (not collectively numbered) for automatically adjusting the stride length **SL** and/or the stride height **SH** of the closed loop path **70p** traveled by the foot supports **70** based upon the sensed speed of travel of the foot supports **70**.

[0023] As shown in FIGs. 1, 2, 6, 9 and 10 the frame **20** includes a base (not separately numbered) for stably supporting the exercise device **10** on a floor (not shown), and a plurality of stiles, rails, stanchions and other supporting members (not separately numbered) as necessary and appropriate to operably support the components of the exercise device **10**.

[0024] As shown in FIGs. 2, 3, 6, 8, 10, and 11, a drive shaft **30** is supported by the frame **20** for rotation about a transverse axis **z**. An extension element(s) (not collectively numbered) is rigidly attached to the drive shaft **30** and extends substantially orthogonally from the drive shaft **30**. A variety of suitable extension element(s) are known to those skilled in the art, including

specifically, but not exclusively, bent end portions (not shown) of the drive shaft **30**, a pair of crank arms **40**, a drive pulley **50**, *etc.*

[0025] As shown in FIGs. 2 and 3, when the extension elements are crank arms **40** each crank arm **40** has a first end **40a** rigidly attached proximate a transverse end (not separately numbered) of the drive shaft **30** for imparting rotational motion of the crank arms **40** about the transverse axis **z** to the drive shaft **30** and interlocking the crank arms **40**.

[0026] As shown in FIGs. 6, 8, 10 and 11, when the extension element is a drive pulley **50** the drive pulley **50** is rigidly attached the drive shaft **30** at the center (not separately numbered) of the drive pulley **50** for imparting rotational motion of the drive pulley **50** about the transverse axis **z** to the drive shaft **30**.

[0027] Foot supports **70** are supported upon first and second foot links **60**. The foot supports **70** may be supported upon the foot links **60** at any point along the length (unnumbered) of the foot links **60** so long as the foot link **60** moves in a closed loop path at the point of connection (unnumbered). For example, the embodiment of the invention shown in FIGs. 1-4 laterally positions the foot supports **70** in the second lateral direction $\mathbf{x_2}$ from the point (not numbered) at which the foot link **60** is supported by the guide rail **120**. The embodiment of the invention shown in FIGs. 6-8 positions the foot supports **70** between the point (unnumbered) at which the foot link **60** is pivotally connected to the crank arm **40** and the point $\mathbf{p_1}$ at which the foot link **60** is pivotally connected to the front guide arm **221**. Other embodiments are also possible. The embodiment of the invention shown in FIGs. 9-11 positions the foot supports **70** between the point (unnumbered) at which the foot link **60** is pivotally connected to the front drive pulley **50a** and the point (unnumbered) at which the foot link **60** is pivotally connected to the rear drive pulley **50b**. Other embodiments are also possible.

[0028] The first and second foot links **60** may be associated with the frame **20** in a variety of different ways to accomplish and impart the necessary closed loop path of travel to the foot supports **70** attached to the foot links **60**. Exemplary connective structures and arrangements are disclosed in United States Patent Nos. 3,316,898 issued to Brown, 5,242,343 issued to Miller,

5,352,169 issued to Eschenbach, 5,383,829 issued to Miller, 5,423,729 issued to Eschenbach, 5,518,473 issued to Miller, 5,529,554 issued to Eschenbach, 5,562,574 issued to Miller, 5,577,985 issued to Miller, 5,611,756 issued to Miller, 5,685,804 issued to Whan-Tong et al., 5,692,994 issued to Eschenbach, 5,707,321 issued to Maresh, 5,725,457 issued to Maresh, 5,735,774 issued to Maresh, 5,755,642 issued to Miller, 5,788,609 issued to Miller, 5,788,610 issued to Eschenbach, 5,792,026 issued to Maresh et al., 5,803,871 issued to Stearns et al., 5,836,854 issued to Kuo, 5,836,855 issued to Eschenbach, 5,846,166 issued to Kuo, 5,848,954 issued to Stearns et al., 5,857,941 issued to Maresh et al., 5,876,307 issued to Stearns et al., 5,876,308 issued to Jarvie, 5,879,271 issued to Stearns et al., 5,882,281 issued to Stearns et al., 5,882,281 issued to Stearns et al., 5,893,820 issued to Maresh et al., 5,895,339 issued to Maresh, 5,897,463 issued to Maresh, 5,911,649 issued to Miller, 5,916,064 issued to Eschenbach, 5,919,118 issued to Stearns et al., 5,921,894 issued to Eschenbach, 5,924,963 issued to Maresh et al., 5,935,046 issued to Maresh, 5,938,568 issued to Maresh et al., 5,938,570 issued to Maresh, 5,947,872 issued to Eschenbach, 5,957,814 issued to Eschenbach, 5,993,359 issued to Eschenbach, 5,997,445 issued to Maresh et al., 6, 126,574 issued to Stearns et al., 6, 248,044 issued to Stearns et al., 6,024,676 issued to Eschenbach, 6,027,430 issued to Stearns et al., 6,027,431 issued to Stearns et al., 6,030,320 issued to Stearns et al., 6,042,512 issued to Eschenbach, 6,045,487 issued to Miller, 6,045,488 issued to Eschenbach, 6,053,847 issued to Stearns et al., 6,063,009 issued to Stearns et al., 6,077,196 issued to Eschenbach, 6,077,197 issued to Stearns et al., 6,077,198 issued to Eschenbach, 6,080,086 issued to Stearns et al., 6,083,143 issued to Maresh, 6,090,013 issued to Eschenbach, 6,090,014 issued to Eschenbach, 6,099,439 issued to Eschenbach, 6,113,518 issued to Maresh et al., 6,123,650 issued to Birrell, 6,135,923 issued to Stearns et al., 6,142,915 issued to Eschenbach, 6,146,313 issued to Whan-Tong et al., 6,165,107 issued to Birrell, 6,168,552 issued to Eschenbach, 6,171,215 issued to Stearns et al., 6,171,217 issued to Cutler, 6,176,814 issued to Eschenbach, 6,183,397 issued to Stearns et al., 6,183,398 issued to Rufino et al., 6,190,289 issued to Pyles et al., 6,196,948 issued to Stearns et al., 6,206,804 issued to Maresh, 6,210,305 issued to Eschenbach, 6,217,485 issued to Maresh, 6,248,045 issued to Stearns et al., 6,248,046 issued to Maresh et al., 6,254,514 issued to Maresh et al., 6,277,054 issued to Kuo, 6,283,895 issued to Stearns et al., 6,302,825 issued to Stearns et al., 6,312,362 issued to Maresh et al., 6,338,698 issued to Stearns et al., 6,340,340 issued to Stearns et al., 6,361,476 issued to Eschenbach, 6,387,017 issued to Maresh, 6,390,953

issued to Maresh et al., 6,398,695 issued to Miller, 6,409,632 issued to Eschenbach, 6,409,635 issued to Maresh et al., 6,416,442 issued to Stearns et al., 6,422,976 issued to Eschenbach, 6,422,977 issued to Eschenbach, 6,436,007 issued to Eschenbach, 6,440,042 issued to Eschenbach, 6,454,682 issued to Kuo, 6,461,277 issued to Maresh et al., 6,482,130 issued to Pasero et al., 6,482,132 issued to Eschenbach, 6,500,096 issued to Farney, 6,527,677 issued to Maresh, 6,527,680 issued to Maresh, 6,540,646 issued to Stearns et al., 6,544,146 issued to Stearns et al., 6,547,701 issued to Eschenbach, 6,551,217 issued to Kaganovsky, 6,551,218 issued to Goh, 6,554,750 issued to Stearns et al., 6,565,486 issued to Stearns et al., 6,569,061 issued to Stearns et al., 6,575,877 issued to Rufino et al., 6,579,210 issued to Stearns et al., 6,612,969 issued to Eschenbach, 6,629,909 issued to Stearns et al., and United States Patent Application Publication Nos. 2001/0011053 filed by Miller, 2001/0051562 filed by Stearns et al., 2002/0019298 filed by Eschenbach, 2002/0055420 filed by Stearns et al., 2002/0128122 filed by Miller, 2002/0142890 filed by Ohrt et al., 2002/0155927 filed by Corbalis et al., 2003/0022763 filed by Eschenbach, which disclosure is hereby incorporated by reference.

[0029] One specific embodiment of a structure for operably interconnecting the first and second foot links **60** with the frame **20** is shown in FIGs. 1-4. This embodiment has (i) a first end portion **60a** of each foot link **60** indirectly pivotally attached, through a connecting system (not collectively numbered) to the second end **40b** of a crank arm **40** at a point spaced from the transverse axis **z** for travel along a closed loop path **61p** relative to the transverse axis **z**, and (ii) a second end portion **60b** of each foot link **60** supported by a roller **69** upon a guide rail **120** for reciprocating travel of the second end portion **60b** of the foot link **60** along a lateral path **62p**. An alternate embodiment for supporting the second end portion **60b** of each foot link **60** to the frame **20** is shown in FIG 5, wherein the a second end portion **60b** of each foot link **60** is pivotally attached proximate the second end **121b** of a rear guide arm **121**, which is pivotally attached proximate a first end **121a** of the rear guide arm **121** to the frame **20** at a rear guide arm pivot point $\mathbf{p_6}$ located above the foot link **60**, for reciprocating travel of the second end portion **60a** of the foot link **60** along a lateral path **62p**.

[0030] One suitable connecting system is shown in FIGs. 1-4. The depicted connection system includes (i) a connector link **90** pivotally attached at a first end **90a** to the first end **60a** of

the foot link **60** at a first end foot link pivot point $\mathbf{p_1}$ and pivotally attached at a second end **90b** to a second end **80b** of a rocker link **80** at a rocker pivot point $\mathbf{p_3}$, and (ii) a rocker link **80** pivotally attached at a first end **80a** to the frame **20** and pivotally attached at the second end **80b** to the connector link **90** at the rocker pivot point $\mathbf{p_3}$, wherein the crank arm **40** is pivotally attached at the second end **40b** to the connector link **90** at a crank pivot point $\mathbf{p_4}$ which is positioned intermediate the first end foot link pivot point $\mathbf{p_1}$ and the rocker pivot point $\mathbf{p_3}$.

[0031] A second specific embodiment of a structure for operably interconnecting the first and second foot links **60** with the frame **20** is shown in FIGs. 6-8. This embodiment has (i) a first end portion **60a** of each foot link **60** pivotally attached proximate the second end **221b** of a front guide arm **221**, and pivotally attached proximate a first end **221a** to the frame **20** at a front guide arm pivot point $\mathbf{p_5}$ located above the foot link **60**, for reciprocating travel of the first end portion **60a** of the foot link **60** along a lateral path **62p** and (iii) a second end portion **60b** of each foot link **60** directly pivotally attached to a drive pulley **50** at a point (not numbered) spaced from the transverse axis **z** for travel along a closed loop path **61p** about the transverse axis **z**.

[0032] A third specific embodiment of a structure for operably interconnecting the first and second foot links **60** with the frame **20** is shown in FIGs. 9-11. This embodiment is shown and described in detail in United States Patent Application Publication No. 2002/0055420, the disclosure of which is hereby incorporated by reference. Briefly, this embodiment has (i) a first end portion **60a** of each foot link **60** pivotally supported upon a support shaft **310** which is attached to a front drive pulley **50a** at a point (not numbered) spaced from a first transverse axis $\mathbf{z_1}$ for travel along a first closed loop path **61p** about the first transverse axis $\mathbf{z_1}$, and (ii) a second end portion **60b** of each foot link **60** pivotally supported upon a support shaft **310** which is attached to a rear drive pulley **50b** at a point (not numbered) spaced from a second transverse axis $\mathbf{z_2}$ for travel along a closed loop path **62p** about the second transverse axis $\mathbf{z_2}$. The front drive pulley **50a** and rear drive pulley **50b** are interconnected by a timing belt **340**. A foot support **70** is slidably supported upon each foot link **60** and operably engaged by a rocker link **320** for effecting a reciprocating motion of the foot support **70** along the length of the foot link **60**. Each rocker link **320** has a first end portion **320a** pivotally connected to a respective foot support **70** at pivot point $\mathbf{p_7}$ and a second end portion **320b** pivotally mounted on the frame **20** at

pivot point p_8. Movement of each rocker link **320** is controlled by a drawbar **330**. Each drawbar **330** has a first end portion **330a** constrained to travel in association with the respective foot link **60** relative to the first and second closed loop paths **61p** and **62p** and a second end portion **330b** connected to a respective rocker link **320**. The combination of a rocker link **320** and associated drawbar **330** cooperate to transfer and link travel of the foot link **60** along the first and second closed loop paths **61p** and **62p** to longitudinal sliding of the respective foot support **70** along the respective foot link **60**.

[0033] The exercise device **10** preferably include a system attached to the frame **20** and in communication with the system through which the foot supports **70** are operably associated with the frame **20**, such as a brake **100** and braking control system **110**, for exerting a controlled variable resistive force against movement of the foot supports **70** along the closed loop path of travel **70p**. It is preferred to provide a separate resistance device for each foot support **70**. Many types of resistance devices are known such as pivoting devices, sliding devices, weights on cables or levers, braking motors, generators, brushless generators, eddy current systems, magnetic systems, alternators, tightenable belts, friction rollers, *etc.*, any of which could be effectively utilized in the present invention. Exemplary resistance devices suitable for use in this invention include those disclosed in United States Patents Nos. 5,423,729 issued to Eschenbach, 5,685,804 issued to Whan-Tong et al., 5,788,610 issued to Eschenbach, 5,836,854 issued to Kuo, 5,836,855 issued to Eschenbach, 5,846,166 issued to Kuo, 5,895,339 issued to Maresh, 5,947,872 issued to Eschenbach, 5,957,814 issued to Eschenbach, 6,042,512 issued to Eschenbach, 6,053,847 issued to Stearns et al., 6,090,013 issued to Eschenbach, 6,146,313 issued to Whan-Tong et al., 6,217,485 issued to Maresh, 6,409,632 issued to Eschenbach, 6,482,130 issued to Pasero et al., 6,544,146 issued to Stearns et al., 6,575,877 issued to Rufino et al., and 6,612,969 issued to Eschenbach, which disclosure is hereby incorporated by reference.

[0034] The exercise device **10** also preferably includes an inertia generation system **180** attached to the frame **20** and in communication with the system through which the foot supports **70** are operably associated with the frame **20**. Such inertia generation system **180** are widely known and commonly utilized on stationary exercise equipment. An exemplary inertia generation system **180** is disclosed in United States Patent Application Publication No.

2002/0055420, the disclosure of which is hereby incorporated by reference. This system is shown in FIGs 9-11. Briefly, the system **180** includes a flywheel **181** and a relatively smaller diameter pulley **182** rotatably mounted on opposite sides (unnumbered) of the front stanchion **21**. The flywheel **181** is keyed to the small pulley **182** by a central shaft **183**. A belt **184** is looped about the front drive pulley **50a** and the small pulley **182** to effect rotation of the small pulley **182** when the front drive pulley **50a** is rotated by operation of the foot links **60**. As a result, the flywheel **181** rotates at a relatively faster speed than the front drive pulley **50a** and adds inertia to the linkage assemblies.

[0035] The speed of travel of the foot supports **70** along the closed loop path **70p** can be determined by a variety of systems known to those skilled in the art including specifically, but not exclusively, audible (sensing tone emitted when air moves through a device which emits different tones when air moves through at different speeds), electrical (*e.g.*, sensing current level), magnetic (*e.g.*, detecting rpm as rate at which magnet on rotating element is sensed by stationary sensor), mechanical (*e.g.*, detecting rpm as rate at which flexible finger on rotating element contacts a stationary pressure switch), visual (*e.g.*, detecting rpm as rate at which aperture through rotating element permits light to pass through the rotating element and strike a stationary light sensor or detecting rpm as rate at which reflective area on rotating element reflects light emitted by a stationary light source which is then detected by a stationary light sensor), *etc.*

[0036] Referring to FIGs. 2 and 3, one suitable system **160** for sensing the speed of travel of the foot supports **70** along the closed loop path **70p** includes a magnet **161** attached to a face (unnumbered) of the flywheel **181** at a point radially spaced from the shaft **183**, and a stationary magnetic sensing element **162** (*e.g.*, a reed switch) positioned proximate the face (unnumbered) of the flywheel **181** for sensing the magnet **161** as the magnet **161** passes the magnetic sensing element **162**. Each time the magnet **161** is aligned with the magnetic sensing element **162**, a pulse is registered and a signal is sent to the master control unit **140**. The speed of the foot supports **70** is therefore calculated by the master control unit **140** from the measurement of the number of pulses per minute.

[0037] Other suitable speed sensing systems **160** are well known to those skilled in the art such those shown and described in United States Patent No. 6,095,951 issued to Skowronski et al. at column 11 line 49 through column 12, line 14 and FIGs 2B, 3C and 15, the disclosure of which is hereby incorporated by reference.

[0038] Adjustment of stride height **SH** and/or stride length **SL** may be accomplished in various ways. Two preferred methods, which may be employed individually or in combination, are (i) adjusting the angle of incline of the guide rail **120**, and (ii) adjusting the position of one or more of the pivot points (not collectively referenced) about which an arm or link (not collectively referenced) pivots as the foot supports **70** travel along the closed loop path of travel **70p**.

[0039] A wide variety of systems effective for adjusting the angle of incline of the guide rail **120** are known to those skilled in the art. Exemplary systems suitable for use in this invention are disclosed in United States Patent Nos. Des. 372,282 issued to Passero et al., Des. 388,847 issued to Whan-Tong et al., 5,685,804 issued to Whan-Tong et al., 5,803,871 issued to Stearns et al., 5,836,854 issued to Kuo, 5,836,855 issued to Eschenbach, 5,848,954 issued to Stearns et al., 5,857,941 issued to Maresh et al., 5,882,281 issued to Stearns et al., 5,882,281 issued to Stearns et al., 5,893,820 issued to Maresh et al., 5,938,568 issued to Maresh et al., 5,957,814 issued to Eschenbach, 5,993,359 issued to Eschenbach, 5,997,445 issued to Maresh et al., 6,042,512 issued to Eschenbach, 6,063,009 issued to Stearns et al., 6,090,014 issued to Eschenbach, 6,126,574 issued to Stearns et al., 6,146,313 issued to Whan-Tong et al., 6,168,552 issued to Eschenbach, 6,171,215 issued to Stearns et al., 6,210,305 issued to Eschenbach, 6,254,514 issued to Maresh et al., 6,277,054 issued to Kuo, 6,302,825 issued to Stearns et al., 6,334,836 issued to Segasby, 6,340,340 issued to Stearns et al., 6,422,977 issued to Eschenbach, 6,440,042 issued to Eschenbach, 6,450,925 issued to Kuo, 6,454,682 issued to Kuo, 6,554,750 issued to Stearns et al., 6,612,969 issued to Eschenbach, 6,629,909 issued to Stearns et al., and United States Patent Application Publication Nos. 2002/0019298 filed by Eschenbach, and 2002/0142890 filed by Ohrt et al, which disclosures are hereby incorporated by reference.

[0040] A wide variety of systems effective for adjusting the position of one or more of the pivot points about which an arm or link pivots as the foot supports **70** travel along the closed loop path of travel **70p** are known to those skilled in the art. Exemplary systems suitable for use in this invention are disclosed in United States Patent Nos. 5,562,574 issued to Miller, 5,788,610 issued to Eschenbach, 5,836,854 issued to Kuo, 5,836,855 issued to Eschenbach, 5,882,281 issued to Stearns et al., 5,893,820 issued to Maresh et al., 5,895,339 issued to Maresh, 5,919,118 issued to Stearns et al., 5,921,894 issued to Eschenbach, 5,957,814 issued to Eschenbach, 5,993,359 issued to Eschenbach, 6,027,430 issued to Stearns et al., 6,027,431 issued to Stearns et al., 6,030,320 issued to Stearns et al., 6,045,488 issued to Eschenbach, 6,053,847 issued to Stearns et al., 6,077,196 issued to Eschenbach, 6,077,197 issued to Stearns et al., 6,077,198 issued to Eschenbach, 6,080,086 issued to Stearns et al., 6,090,013 issued to Eschenbach, 6,113,518 issued to Maresh et al., 6,135,923 issued to Stearns et al., 6,171,215 issued to Stearns et al., 6,196,948 issued to Stearns et al., 6,217,485 issued to Maresh, 6,248,044 issued to Stearns et al., 6,248,045 issued to Stearns et al., 6,248,046 issued to Maresh et al., 6,254,514 issued to Maresh et al., 6,277,054 issued to Kuo, 6,283,895 issued to Stearns et al., 6,334,836 issued to Segasby, 6,338,698 issued to Stearns et al., 6,361,476 issued to Eschenbach, 6,387,017 issued to Maresh, 6,390,953 issued to Maresh et al., 6,416,442 issued to Stearns et al., 6,440,042 issued to Eschenbach, 6,450,925 issued to Kuo, 6,547,701 issued to Eschenbach, 6,554,750 issued to Stearns et al., 6,565,486 issued to Stearns et al., 6,579,210 issued to Stearns et al., 6,612,969 issued to Eschenbach, 6,629,909 issued to Stearns et al., and United States Patent Application Publication Nos. 2001/0051562 filed by Stearns et al., 2002/0019298 filed by Eschenbach, 2002/0055420 filed by Stearns et al., and 2002/0142890 filed by Ohrt et al., which disclosures are hereby incorporated by reference.

[0041] Other systems for adjusting stride height **SH** and/or stride length **SL** which may be utilized include specifically, but not exclusively, (a) adjusting the position of the foot supports **70** along the length of the foot links **60**, such as shown and described in United States Patent No. 6,171,217 issued to Cutler, the disclosure of which is hereby incorporated by reference (b) adjusting the position of the roller **69** along the length of the foot link **60**, and (c) adjusting the lateral **x** and/or longitudinal **y** position of the drive shaft **30**, such as shown and described in

United States Patent No. 6,146,313 issued to Whan-Tong et al., the disclosure of which is hereby incorporated by reference.

[0042] One specific embodiment of a system for adjusting stride height **SH** and stride length **SL** is shown in FIGs. 1-4. This embodiment includes a combination of (i) a first pivot point repositioning unit **171** in communication with the master control unit **140** and operably engaging the foot link **60** and the connector link **90** so as to define the first end foot link pivot point $\mathbf{p_1}$ and permit repositioning of the first end foot link pivot point $\mathbf{p_1}$ along the length of the foot link **60** and/or the connector link **90** based upon a control signal from the master control unit **140**, and (ii) an incline adjustment system **130** in communication with the master control unit **140** and operably engaging the guide rail **120** for changing the angle of incline of the guide rail **120** based upon a control signal from the master control unit **140**.

[0043] This embodiment of a system for adjusting stride height **SH** and stride length **SL** may also include (iii) a second pivot point repositioning unit (not shown) in communication with the master control unit **140** and operably engaging the rocker link **80** and the connector link **90** so as to define the rocker pivot point $\mathbf{p_3}$ and permit repositioning of the rocker pivot point $\mathbf{p_3}$ along the length of the rocker link **80** and/or the connector link **90** based upon a control signal from the master control unit **140**, and (iv) a third pivot point repositioning unit (not shown) in communication with the master control unit **140** and operably engaging the crank arm **40** and the connector link **90** so as to define the crank pivot point $\mathbf{p_4}$ and permit repositioning of the crank pivot point $\mathbf{p_4}$ along the length of the crank arm **40** and/or the connector link **90** based upon a control signal from the master control unit **140**.

[0044] The alternative embodiment for supporting the second end portion **60b** of each foot link **60** to the frame **20** shown in FIG 5 may include a pivot point repositioning unit **172** similar to the pivot point repositioning unit **171** shown in FIGs 1-3 (shown in block format in FIG 5) in communication with the master control unit **140** and operably engaging the second end portion **60b** of the foot link **60** and the rear guide arm **121** so as to define the second end foot link pivot point $\mathbf{p_2}$ and permit repositioning of the second end foot link pivot point $\mathbf{p_2}$ along the length of

the foot link **60** and/or the length of the rear guide arm **121** based upon a control signal from the master control unit **140**.

[0045] Another specific embodiment of a system for adjusting stride height **SH** and stride length **SL** is shown in FIGs. 6-8. This embodiment includes a combination of (i) a pivot point repositioning unit **173** similar to the pivot point repositioning unit **171** shown in FIGs 1-3 (shown in block format in FIGs 6 and 7) in communication with the master control unit **140** and operably engaging the foot link **60** and the front guide arm **221** so as to define the first end foot link pivot point $\mathbf{p_1}$ and permit repositioning of the first end foot link pivot point $\mathbf{p_1}$ along the length of the foot link **60** and/or the length of the front guide arm **221** based upon a control signal from the master control unit **140**, and (ii) a linear actuator **230** in communication with the master control unit **140** with a first end of the actuator **230** attached to a fixed position portion of the frame **20** and a second end the actuator **230** attached to vertically adjustable portion of the frame **20** upon which the drive shaft **30** is rotatably mounted, for permitting longitudinal **y** repositioning of the drive shaft **30** relative to the fixed position portion of the frame **20** based upon a control signal from the master control unit **140**.

[0046] Yet another specific embodiment of a system for adjusting stride height **SH** and stride length **SL** is shown in FIGs. 9-11. This embodiment includes a pivot point repositioning unit **174** similar to the pivot point repositioning unit **171** shown in FIGs 1-3 (shown in block format in FIGs 9 and 10) in communication with the master control unit **140** and operably engaging the rocker link **320** and the first end **330a** of the drawbar **330** so as to define a drawbar-rocker pivot point $\mathbf{p_9}$ and permit repositioning of the first end **330a** of the drawbar **330** along the length of the rocker link **320** based upon a control signal from the master control unit **140**.

[0047] A master control unit **140** communicates with the incline adjustment system **130**, speed sensing system **160**, the repositioning unit **171**, and the linear actuator **230** for receiving signals from the speed sensing system **160**, processing those signals to determine the speed of travel of the foot supports **70**, and adjusting the stride length **SL** and/or stride height **SH** of the closed loop path **70p** traveled by the foot supports **70** according to a preprogrammed adjustment in incline and/or pivot point locations, based upon the speed of travel of the foot supports **70**.

[0048] The master control unit **140** is also in communication with a user interface panel **150** as is typical for stationary exercise equipment.